The Stoves Prototype Development Project 2010 to 2011

Joshua B. Guinto Specialist, Sustainable Village Technologies
Ms Agro Ecological Knowledge and Social Change
The Wageningen University at the Netherlands 2006 to 2008
International Fellowships Programme Fellow 2005 Ford Foundation

Acknowledgement

I would like to thank Kuya Buddy Corino of Barangay Putsan, Tiwi, Albay from whom I got my very first training on pottery.

My gratitude also goes to Mr. Rok Oblak. In spite of meeting him only on the net, the collaboration have grown deep and outstretched in an instant to a whole network of champions and disciples of the stove design arena. I have finally succeeded to overcome my failures and frustrations in the past and now could venture to a much wider range of designs and local materials.

I would also like to thank Mr. Richard Stanley for the providing me the books on briquetting and to Mr. Leeland Hite for the video on the micro compound lever press. They helped me greatly to plunge into an adventure of all sorts of biomass materials here in my place.

My thanks also goes to Dr. Paul Richards, my thesis adviser from the Technology and Agrarian Development Department of the Wageningen University. The lessons I gained from my masteral studies now come as a very powerful tool in stimulating local participation, discoveries, innovations and inventions.

To the Interchurch Faith of Wageningen of the Netherlands and the Student Chaplaincy Service of the Wageningen, I would like to thank you deeply, not only for the support but for the trust and confidence that was extended to this project in favor of the poor families of my province.

To my family and co workers, Edgar Sanchez, the family team of Kuya Lando, Ate Poy, Maeng, Daniel, Exequiel and their friend Robin for believing in this project and risking with me the uncertainties of an entirely new technology.

Finally to all potters, stove designers, the clients and the recipients of this project, I thank you for the cooperation and the adventure we jointly surfed along.

Joshua B. Guinto, Specialist, Sustainable Village Technologies
Email: jed.building.bridges@gmail.com

Table of Contents

1. Introduction 3
2. Objectives 7
3. Conceptual Framework.....8
4. Operating Mechanisms 9
5. The Prototypes 10
   5.1. The The Buko Chips Stove 10
   5.2. The Rocket Stove from Old Metal Roof 11
   5.3. The Brick Rocket Stove 12
   5.4. The Paint Can Rocket Stove 13
   5.5. The Wood Gas Stove Micro Model 15
   5.6. The Wood Gas Stove Kitchen Size Model 18
   5.7. The Wood Gas Stove Large Model 19
   5.8. The Wood Gas Stove with Forced Air Fan 22
   5.9. The Forced Air Wood Gas Stove in Terra Cotta 25
   5.10. The Vertical Feeding Roket Stove 26
   5.11. The 45 degree Self Feeding Terra Cotta Stove 27
   5.12. Mr. Booh Holey Roket Stove 29
   5.13. Single Barrel Holey Roket Stove 30
   5.14. Double Barrel Holey Roket Stove 32
   5.15. Holey Roket Barbeque Grill 34
   5.16. The Holey Briquettes 38
   5.17. The Micro Compound Lever Press 39
   5.18. The Rocket Stove Kiln April 2011 Model 41
   5.19. The Rocket Stove Kiln September 2011 Model 42

6. Field Tests and Clients' Response
   6.1. At my own house 46
   6.2. Edwin Millamina 46
   6.3. Flora Pancho 47
   6.4. Sally Encinas 47
   6.5. Isabelita Dando.....48
   6.6. Dra. Tejada.....48
   6.7. Lilibeth Ravida 49
   6.8. Bert Ella 49
   6.9. Nelson Mabesa 49
   6.10. Gina Reyes 50
   6.11. The Family of Efren Abasula 51
   6.12. Winifreda Tolin 57
   6.13. Sara Bernardino.....59
   6.14. Bayani and Lolit 59

Joshua B. Guinto, Specialist, Sustainable Village Technologies
Email: jed.building.bridges@gmail.com

7. Conclusion 63
8. Windows Unfolding.....64
9. Plans and Ambitions 66

Joshua B. Guinto, Specialist, Sustainable Village Technologies
Email: jed.building.bridges@gmail.com

The Stoves Prototype Development Project

2010 to 2011

Joshua B. Guinto
Specialist, Sustainable Village Technologies
Ms Agro Ecological Knowledge and Social Change (MAKS)
Wageningen University, The Netherlands 2006 to 2008
International Fellowships Program Fellow 2005 Ford Foundation

1. Introduction

Forest conservation, clean indoor air, family savings come together from a well designed stove with a strongly embedded support mechanisms. And while there is an active network of stove fabricators in many countries, thousands of families in my province like in many parts of the world still do not have access to these benefits.

And so I personally took up the challenge of finding solutions during my dissertation under the masters program at the Wageningen University at the Netherlands. From 2007 to 2008, I was then doing my own research among scientists and villagers in evaluating the technology design process of each stove model. The thesis entitled "Realistic Evaluation of Stove Design Process" was under the supervision of Prof. Dr. Paul Richards of the Technology and Agrarian Reform Group of the Social Science Department. My thesis culminated in the fabrication of a hybrid model that is the infusion of the research technology from the university and the traditional technology in a village. The stove is made of clay, fed with wood sticks and infused with steam injector that reinforces the fire.

Upon coming home and during the floods of 2008, i persisted in finding solutions for the flood victims of my province. With a support from the Student Chaplaincy Service of the Wageningen University, I fabricated and delivered training sessions on how to build the rocket stove from scrap metal roofing materials and soil in less than two (2) hours.

Realizations

A year after this project, I visited the neighborhoods to which I delivered the stove fabrication sessions. From the conversations with the key persons these are the realizations that I gathered.

- The stoves served the families for several months. They were able to save money from buying wood charcoal. One neighborhood would even bring the stove they built to the evacuation center whenever there is flooding. This helped them greatly to ease the burden of finding too much fuel and to cook at will.

- The stoves models that I offered during the previous project are very limited to the use of metal as the basic stove body.

- Although old metal roof is a scrap material, it is still difficult to find. Such a scrap material will still be used by the poor families to cover some holes in their house before they would decide to use it to build a stove.

- The stove model that I offered cannot be carried if they move to the evacuation center. And if submerged to flood waters, the stoves would easily disintegrate. The stove that the neighbors would bring to the evacuation center eventually broke off while on transport.

- Clay is an excellent stove building material and it is abundant in many parts of the province and would most likely be more accessible to the families than metal.

Joshua B. Guinto, Specialist, Sustainable Village Technologies
Email: jed.building.bridges@gmail.com

With these realizations, this project expanded to find a wider set of options and by way of self experience, I will be able to offer a diverse set of solutions to the communities, not only because I heard or read about it, but because I personally engaged in the design and fabrication of the stove models.

For this episode, I directly engaged in the design and fabrication of fourteen (14) models of stoves, two (2) models of kiln and the fabrication of the briquette press. This magnifies the strength of the participatory design process, wherein I could act not only as a passive researcher and facilitator but as an active part of the entire design process.

With this report, I would like to thank the ICF for the financial support that it provided. Although it began as a response to the flood victims, I believe, this project was able to achieve a far more lasting and meaningful pool of solutions to their benefit. It expanded the search to wood gas stoves, forced air fan and the use of metal and clay. It ended with fourteen (14) prototypes and earns valuable lessons, insights and recommendations. Furthermore, I was able to join a worldwide network of inventors and scientists and by now an active part of the open exchange. My latest work may be viewed at the website www.holeyroket.wordpress.com.

2. Objectives

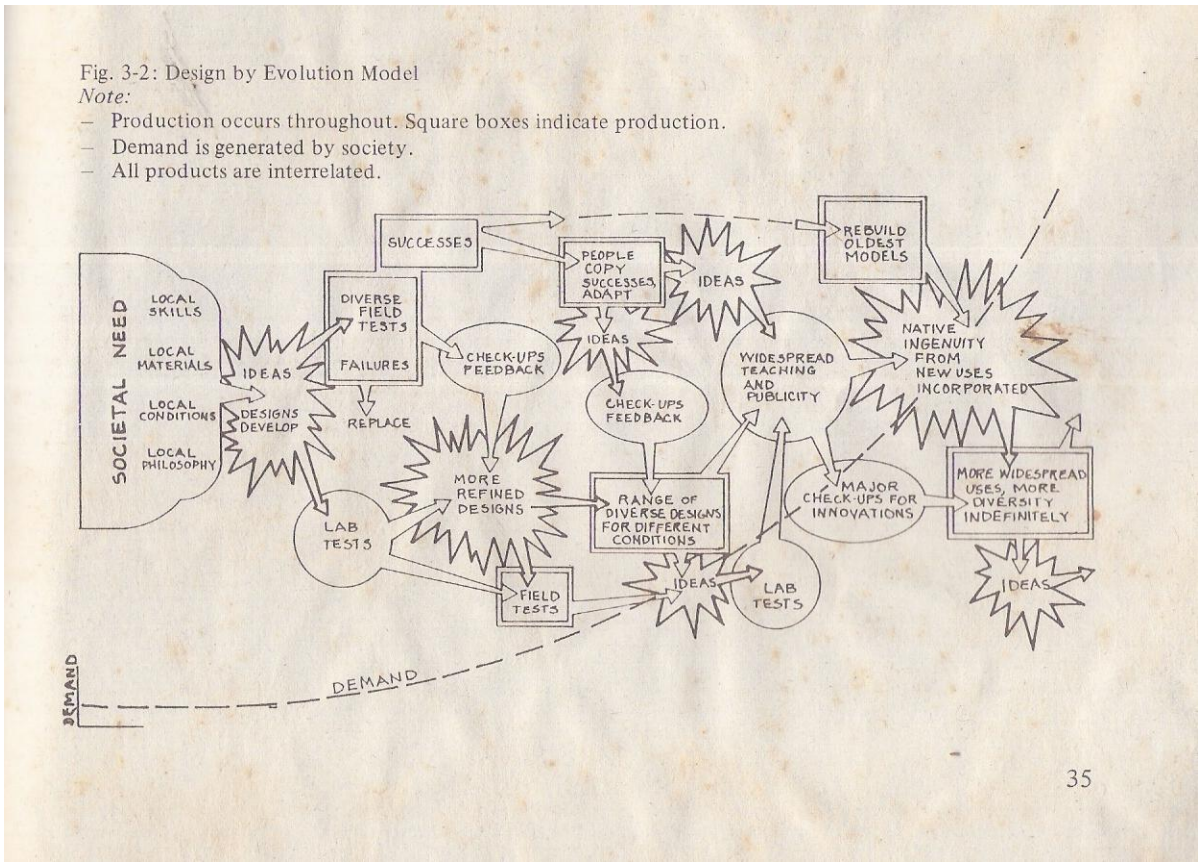
To provide a pool of intelligent choices for the communities of my province for the stove models or its operating mechanisms which they may find appropriate for their own solutions.

To evaluate the technologies in the domain of stoves through self experience.

To solicit feedback from the clients and make necessary recommendations.

Joshua B. Guinto, Specialist, Sustainable Village Technologies
Email: jed.building.bridges@gmail.com

3. **Conceptual Framework**



Source : Improved Cookstoves by Aprovecho Institute.

This project is inspired by the Design by Evolution Model by the Aprovecho Resarch Institute. I also used the same model in my master's thesis. The model argues that an open and free access to technology is necessary to allow a proliferation of stove models. It stimulates participation, local inventiveness and a sense of ownership. The users will be allowed to define the design of the stoves that best suits their needs. There are those who will work on laboratories, others on their workshops and others on their own homes. Others will be successful and others will have their failures. People will select and copy the best innovations through a cycle of feedbacks and renovations. Although the process is slow, it allows a rich pool of discoveries, invention with a set of models that are precisely fit to the needs of the users.

Joshua B. Guinto, Specialist, Sustainable Village Technologies
Email: jed.building.bridges@gmail.com

4. Operating Mechanisms

4.1. **Contextualized Observations**. Stoves evolve in every specific socio-technical and ecological contexts. Each stove model have its own purpose, its own set of materials built from, its impact to the immediate micro environment and finally, its interaction with the pool of providers of materials, including fuel and users. With this concept, I consciously initiated conversations with the local fabricators and users of the different stove models. There are those at the households, the informal restaurants we call *carenderias,* the restaurants, and the street food vendors. I also conducted conversations with the producers of fuel namely the wood charcoal producers as well as the generators of agricultural wastes specifically the rice husks and the buko (green coconut) shells.

4.2. **Self Experience.** The highest and most effective methodology for research is for me as the researcher to be embedded and in a highly interactive mode with the actors in the domain. And doing so, I practically experienced every bit of the activities in the domain. I gathered rice husks my self from the rice mills, I gathered, chopped and dried buko chips, I hauled clay, dried, milled, kneaded, shaped and fired them. I designed and fabricated the stove models myself with a team of workers that works along in every activity.

4.3. **Participatory Design**. With a good stock of knowledge of the people and the stove models they are using coupled with my self experience in the designs, I initiated the next level of conversations in every context. During each conversation, there is always a dialogue between what clients want, what are their problems with their stoves and fuels and between what I have achieved and what I offer.

4.4. **Local Resource Mobilization**. Every context would have their own set of local materials, fuel supply as well as pool of knowledge and skills. Throughout this project, I discovered local sources of clay, rice husks, buko chips, bamboo, molasses, cow manure, coco fiber and wood chips and the best method on how to mobilize them. I have also discovered village artisans including stove fabricators and the means to stimulate their participation.

Joshua B. Guinto, Specialist, Sustainable Village Technologies
Email: jed.building.bridges@gmail.com

4.5. **Feedback and Renovations**. While conversations on purely sociological matters deal with concepts and ideas, this socio technical project require an artifact as a point of conversation. The strength of this project therefore is having the stove units and fuel as an element in the conversation while being guided by the abstract mechanisms, which the clients are not very much interested in. As of this writing, I have given away ten (10) stoves to families who are in different context. The purpose is for them to test the models in the actual and diverse set of context.

5. The Prototypes

5.1. **The Buko Chips Stove.** The stove was designed for the poor urban households of Metro Manila who are in the growing crisis of buying wood charcoal for fuel. In the urban settlements, the reliable source of fuel would be buko shells. Buko is the green coconut that is consumed while the juice and meat is still tender and the water is sweet. It is sold in carts by street vendors and is consumed fresh. The street vendors however are having difficulties in disposing the spent shells.

If dried, the shells become a very powerful and cheap fuel for cooking. However, it would require an improved kind of stove in order to burn the smoke and other emission which the shells are known to emit heavily.

The stove was inspired by the concepts and techniques of the rocket stove by Dr. Larry Winiarski. At its very raw stage was made out of used oil tin cans. The insulating layer was made of a mixture of clay and again, buko chips. It has a vertical fuel feeder which was expected to allow the fuel to fall by itself to the fire chamber as they burn.

5.1.1. Results of the Tests.

Joshua B. Guinto, Specialist, Sustainable Village Technologies
Email: jed.building.bridges@gmail.com

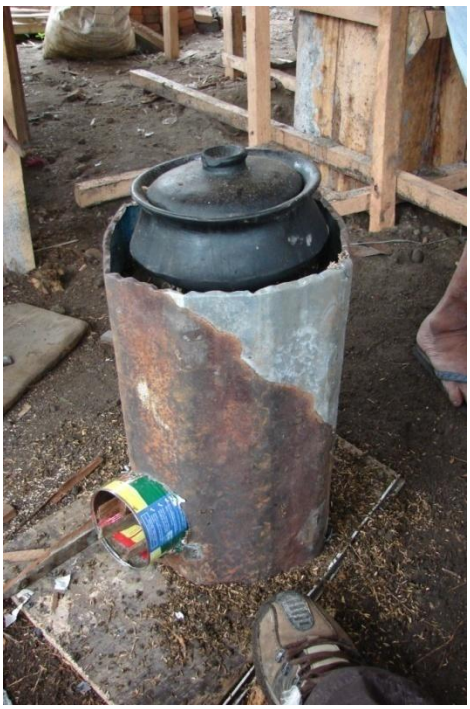
- The stove burned very strong using the dried buko chips.
- It smoked heavily however during continuous cooking. The buko chips in the fuel feeder did not fall neatly. As soon as one chip got stuck in the feeder from falling, the flames would be misdirected and will soon burn the fuel while they are still in the fuel feeder.
- After three months of continuous use, the stove body begins to succumb to rust and the entire stove begins to disintegrate.

5.1.2. Insights

- The buko shells should be chopped smaller so they would fall in the chamber neatly. This however, would require additional effort in chopping the shells.
- Install a 45 degree fuel feeder so as to cut into half the back draft of the misdirected flames.
- The use of tin cans will allow the families to fabricate the stove in less than two hours. However, the life of the stove is limited only to several months of use.
- Use terra cotta (fired clay) offers a more lasting solution but access to the clay and a kiln will exclude a good number of urban dwellers.

5.2. **The Rocket Stove from Old Metal Roof.**

This model was earlier fabricated in 2009. It is a rocket stove made out of scrap metal roof and tin cans. It burns strong even in windy situations. The fire chamber is insulated with soil, ash or clay. It is very crude and can be fired immediately. However, it is not durable neither mobile and would last only for a few months or until the metal body lasts.



Joshua B. Guinto, Specialist, Sustainable Village Technologies
Email: jed.building.bridges@gmail.com

5.3. **The Brick Rocket Stove.** The stove design followed the prescriptions of Dr. Larry Winiarski in several of his videos in the you tube. By the time of my growing interest with the brick rocket stove, I was already doing some experiments to produce my own bricks that are intended for the walls of my house that I would soon build. I made a wooden mold for lego shaped interlocking bricks. The stove uses 16 pieces of bricks, some of which had to be cut into the prescribed shapes in the fire chamber. Metal grates had to be fabricated as well as longer fuel shelf.

5.3.1. **Results of the Tests.**

- The brick rocket stove demonstrated a much cleaner burn than the buko chips stove. It also demonstrated a much stronger insulating effect which keeps the stove body cooler during continuous cooking than the previous model.
- As soon as it is well heated, the stove would only require two pieces of wood fuel for continuous cooking compared to five pieces of wood fuel in an equivalent open three stone stove.
- The stove however is very heavy, with a weight of more than 20 kilograms.
- In order to be able to move the stove and protect it from breakage, we had to install a metal wrap around the body. With the metal casing, we were able to install a handle while keeping the bricks safe from accidental breakage.
- The intricacy of the fabrication and the required metal works ended up in an expensive kind of stove which excluded most of the poor

Joshua B. Guinto, Specialist, Sustainable Village Technologies
Email: jed.building.bridges@gmail.com

families from its benefits. To my best estimate, each stove should be sold at Php 1,700 each.

5.3.2. Insights

- Learn how to produce much lighter kind of bricks by increasing the amount of biomass materials in the clay mix. Dr. Winiarski prescribes a mixture of 6 parts of sawdust to one part of clay.
- Test the use of rice hull for the mix.
- Create another component out of bricks for the extended fuel shelf.
- To cut down the cost of installing the metal casing, a better option would then be to focus on the production of pre cast light weight bricks and teach people how to make the stove on their own in a series of skills training for stove artisans.

5.4. **The Paint Can Rocket Stove.** In response to the high cost of the brick rocket stove, this model will be a much smaller version and will use spent cans. At the time of the experiment, it is the paint cans that are widely available in the market. This is a direct attempt to make a stove that is durable, lightweight and compact which the evacuees may find handy.

5.4.1. The innovations on this model are the following:

- The insulation out of cement, ash and broken terra cotta pieces.
- The fuel shelf was also made from used metal sheets.
- The stove platform was made from steel bars and was welded together.
- The stove body had to be painted with an anti rust spray paint to prolong its life.

5.4.2. Results of the Tests

Joshua B. Guinto, Specialist, Sustainable Village Technologies
Email: jed.building.bridges@gmail.com

- The stove gave a clean burn with a bit of sooth.
- It however required much smaller pieces of wood sticks. It has very limited burning intervals because of the small amount of ember that can be earned while firing. Thus, it required more attention for feeding the fuel and expelling the ash during cooking.
- It also required skills on arc welding and basic masonry.
- The insulation layer was complicated to make and they do not hold very long.
- I conducted market tests with the model. My conclusion is that a business enterprise would be profitable if they are sold at Php 400 pesos each.

Joshua B. Guinto, Specialist, Sustainable Village Technologies
Email: jed.building.bridges@gmail.com

5.4.3. Insights

- The stove offers a solution for those who needed a highly mobile and light weight stove which they can carry. It appeals to travelers, picnic goers, and emergency situations such as evacuation and outdoor camps.

- I am very much worried about the toxic emissions coming out from the stove body, in particular the paint that is being slowly burned while cooking.

- The durability of the stove is as good as the metal part holds.
- The additional requirement of metal works increases the cost of the stove as well as exclude majority of the village artisans who do not posses arc welding skills.
- Future models should allow longer feeding intervals which will also allow house hold members to perform other tasks in the kitchen while cooking.
- Future models should also use terra cotta as an insulating layer.

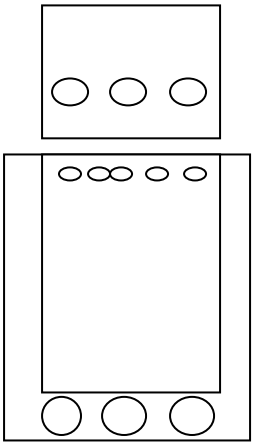
5.5. **The Wood Gas Stove Micro Model.** This responds to the challenge of making the cost of the stove much cheaper and the stove much lighter. I found this design in the you tube and instantly got inspired to face the challenges upfront.

5.5.1. **Features**. This model can be built in less than an hour with three tin cans and a few hand tools. Holes were perforated on each of the cans to allow different mixes of air for proper and stronger combustion of the fuel.

My model however required arc welding works to create a sturdier stand for the pot for safety. The stove is fed with wood chips and burns very clean. Three hundred (300) grams of wood chips can already cook half a kilogram of rice or boil two liters of water.

Joshua B. Guinto, Specialist, Sustainable Village Technologies
Email: jed.building.bridges@gmail.com

I



5.5.2. Upsides.

- It is very cheap to build, very light and very powerful.
- The stove can be made in less than two hours with a minimum set of skills and tools.
- It responds to the requirements of outdoor and mobile cooking such as at evacuation centers and outdoor camps.
- It burns very clean and has a stable flame.

5.5.3. Downsides.

- Continuous cooking is only possible by reloading nly by dropping wood chips one by one lest it will smoke heavily.
- Does not last very long and gives in to rust if neglected and tear if used intensely.
- It also wastes too much heat. The tin can gets red hot.
- Tin cans have a thin coating of galvanization. This thin coating when burned produces a very toxic kind of gas.
- It however required small fuel chips thus all fuels must be chopped small manually or by machine. Wood chips in my place are a rare commodity. There are no reliable supplies of wood chips thus would demand a lot of effort to prepare the fuel.

Joshua B. Guinto, Specialist, Sustainable Village Technologies
Email: jed.building.bridges@gmail.com

- It is also very unstable. The stove weighs less than two kilograms and is top heavy as soon as the pot is placed on its top. As a remedy, I again had to fabricate platforms using metal bars.
- As a test, I tried selling a few units of this model. I concluded that a price of Php 150 would be a reasonable price. However the biggest complaint against the model is the durability of the metal can against continuous use.

5.5.4. Insights

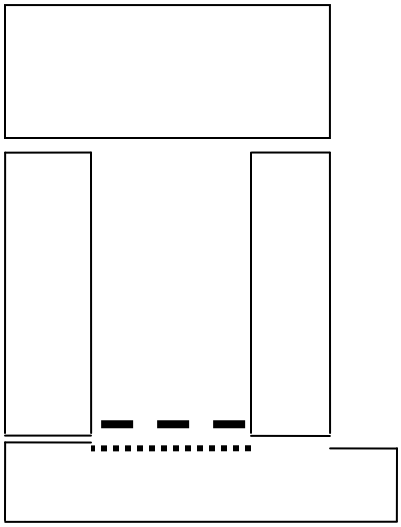
- This model demonstrates the full potential of the fuel chips if coupled with a well designed stove. It demonstrates about how the pyrolized gases are in fact source of energy which are otherwise wasted as air pollution in the poorly designed stoves.
- It also comes with its limitations. First, it requires wood chips. This particular requirement meant that household members will have to chop their fuel small which means additional energy input.
- It is batch fed thus the flames will die out as soon as the first load of fuel is spent. Its can be extended however by dropping more bits of fuel one by one through the top but that will already require higher amount of attention. Furthermore, dropping fresh fuel at the top increases the emissions of smoke and possibly carbon monoxide.

- The model is ideal for camping and emergency use such as during evacuation of climate refugees.
- Anyone who is serious about the mass production of this stove as a business enterprise will have to organize a fabrication workshop at the garbage dump where tin cans can be regularly collected.
- He/she will also have to procure a wood chipping machine as well as a regular supply of wood chips. For this concern, I went further in testing the wood chips that the RU Shredding machine by the Bureau of Soils of the Department of Agriculture. The chips that it produces however are much too small for what the stove would require.

Joshua B. Guinto, Specialist, Sustainable Village Technologies
Email: jed.building.bridges@gmail.com

5.6. References This video clip was particularly helpful :
http://www.youtube.com/watch?v=YfrBdp11pyE

5.7. **The Wood Gas Stove Kitchen Size Model**



Joshua B. Guinto, Specialist, Sustainable Village Technologies
Email: jed.building.bridges@gmail.com

5.7.1. Features

- In addition to the camp size model, this features a sliding canister for expelling the ash. The canister is fixed at the base of the stove. It has one section of perforated tin can that holds the wood chips in place but allows primary air to pass through. The ash may be expelled by simply sliding the canister to allow the ash to fall into the open slot of the canister.
- I used a mixture of ash, cement and broken bricks as an insulating layer between the fire chamber and the stove body.

5.7.2. Upside

- The flame is very strong and clean at the beginning.
- It is very light and weighs less than 6 kilograms.
- The ash may be expelled with less spillage.

5.7.3. Downside

- The stove body gets very hot after one cooking session that it will burn a bare hand.
- The flame gets dirty and smoky after the first burst of flames. I think it is because the air passage between the wood chips has already collapsed.

5.7.4. Insights

- The use of forced air into the fuel may help solve the problem.
- Use better insulating materials as stove body. Terra cotta would be a much better option.
- Metal container such as this may be a limiting component for the popularization of the stove.

5.8. **The Wood Gas Stove Large Model.** For this model, I took up the limitation of the preceding TLUD model in terms of its size and the length of cooking time. With lessons coming from the models of Art Donelly, I built my own model. It is simply the bigger version of the TLUD Wood Gas stove. The metal cans are bigger and the pot rests this time are made of bolts and nuts

Joshua B. Guinto, Specialist, Sustainable Village Technologies
Email: jed.building.bridges@gmail.com

and washers. Furthermore, I fabricated steel bars to become as more stable pot rests. I also responded to the limitation of the small TLUD which requires chopping the fuel into small bits by creating a much bigger wood gas stove that can receive bigger chunks of fuel.

5.8.1. **Features.** I learned the design of this stove from the model of Mr. Art Donnely. I did not have the specific construction plan and only fabricated them using the instructions for the stove camp model and magnified it to the size of Mr. Donnely's model.

5.8.2. **Upside.** It burns very strong and can receive big chunks of fuel. It can be built in less than three (3) hours and is very light.

5.8.3. Downside.

- The metal will corrode very fast. It also wastes a lot of heat.
- It is not safe. Accidental burns may happen. The stove becomes top heavy light as soon as the fuels are spent.
- It is very difficult to control as soon as the flames picked up its momentum.

Joshua B. Guinto, Specialist, Sustainable Village Technologies
Email: jed.building.bridges@gmail.com

Joshua B. Guinto, Specialist, Sustainable Village Technologies
Email: jed.building.bridges@gmail.com

On one evening, I went to the beach in my town. There I found piles of debris on the sand. They are washed onshore from the recent flooding. I found chunks of wood, coconut husks, bamboo poles and many other assorted kinds of biomass fuels. I place the bigger fuel at the bottom and the smaller fuel at the top of the stove.

After about twenty (20) minutes, the stove is with a stable and clean flame. After another fifteen minutes, the flames began to grow bigger. What I needed is a stable and regulated flame so I covered some of the holes at the bottom with sand. This reduced the intensity of the flame but increased the amount of smoke.

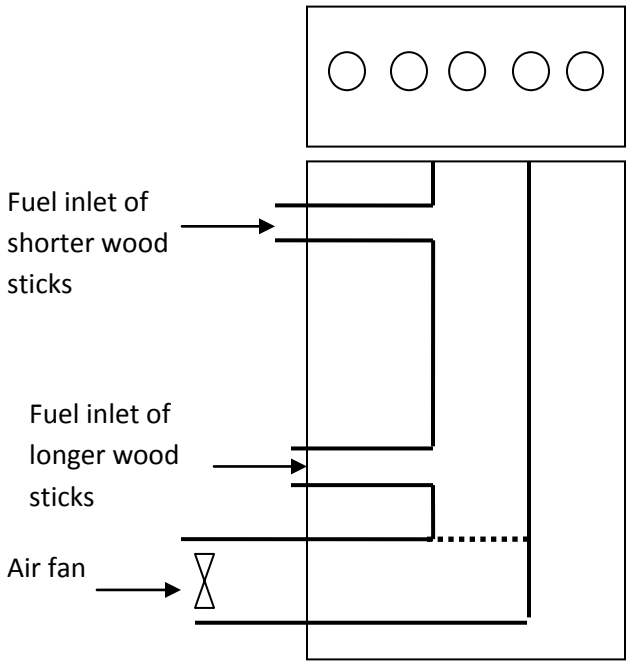
On the following evening, I went to the village adjacent to the beach to demonstrate the performance of the stove and to solicit some feedback. We lit the small TLUD stove and it was able to cook rice. Immediately after, we lit the bigger TLUD stove and one woman was convinced to cook her coconut milk porridge in the stove. However, after fifteen minutes of stable flame, the smoke went big. I had to raise the stove from the ground by placing it on top of three small pieces of gravel. And then, the flames went really big, about as six feet tall. The woman grabbed her porridge off the stove.

The bigger TLUD stove was later bought by another woman at Php 200. Still, she insisted that I build for her a bread oven instead.

5.8.4. References : http://www.youtube.com/watch?v=eGIVh-zMWgY

5.9. **The Wood Gas Stove with Forced Air Fan.** This model responds to the earlier problem of the tall wood gas stove where the heat does not reach the pot effectively as soon as the flames are already deep down at the bottom of the chamber. This time, the model has a much shorter distance between the fuel and the pot while controlling the air to achieve a more controlled flame. It is compact and can be carried off easily.

Joshua B. Guinto, Specialist, Sustainable Village Technologies
Email: jed.building.bridges@gmail.com



Building up from the lessons I learned from the previous models, this stove has an air fan that pushes air below the fire chamber. After firing the first batch of fuel inside the chamber, more wood chips may be dropped at the upper fuel chamber. I also attached another fuel inlet just above the blower. My theory is that the lower fuel inlet will reduce the need to cut the wood sticks into smaller bit by simply pushing a long wood stick into this inlet.

5.9.1. **Results of the tests.** There was a stable burn at the beginning. After about ten minutes, additional fuel bits will have to be added. This extends the burn longer each time fresh fuels are added. It seems like the problem of the control is resolved until new problem emerged. There is too much heat loss whenever the fan blows fresh incoming air which is cold and so the flames do not last which requires that fresh fuel be dropped in less than about one minute.

Joshua B. Guinto, Specialist, Sustainable Village Technologies
Email: jed.building.bridges@gmail.com

Furthermore, the ash is blown out of the chamber along with the flames thus makes the vicinity of the stove very messy.

5.9.2. Insights

- The models of the wood gas stoves that I built showed its excellence as well as limitations. It is excellent in providing a clean burn provided that the fuel is chipped small. This requirement therefore opens the stove to be effective in situations where such fuel bits are available. In my own province, wood chips are hardly available.
- The metal body may be emitting toxic gases because of the paint being burned while cooking. Safer materials will have to be used. Terra cotta, however heavy and brittle is a good option in terms of safe emissions.
- This requires metal and arc welding skills, tools and instruments.
- It relies on the air fan for added power thus more fixture and power requirement.
- Forced air fans pushes fresh air but is cold thus robs away the momentum of the stove. This means a lot of loss of heat making it very difficult to re start the flame. Without pre heating of the fuel and incoming air, I think there is an increase in carbon monoxide every time fresh fuel is dropped.
- This prototype requires a lot of attention; fresh fuels need to be dropped immediately in sequence, lest the heat will dissipate quickly. As a remedy, a fuel feeder may be installed in the form of a long metal tube that contains the fuel in sequence. The tube is in an

Joshua B. Guinto, Specialist, Sustainable Village Technologies
Email: jed.building.bridges@gmail.com

angle that will drop the fuel bits in sequence as soon as the ones ahead are already spent.

- Other models will have to be built in order to address the limitations of the wood gas stoves.

5.9.3. **The Forced Air Wood Gas Stove in Terra Cotta.** The only innovation of this from the previous model is the use of terra cotta (fired earth) instead of metal. I also added two more fuel inlets which allow fuel to come together but will have enough spaces in between. Although clay works is an entirely new set of skills, it cuts down the cost of the materials while improving the durability of the stove to intense heat.

5.9.4. Upside

- Terra cotta does not rust and would last much longer than metal.
- Much cheaper to fabricate.

5.9.5. Downside

- Much heavier than the metal counterpart.
- Almost all of the ashes are blown off the stove and would scatter in the entire kitchen.
- The flame goes off all the way as soon as no fresh fuel are added and is difficult to re ignite.

5.9.6. Results of the Tests.

In a similar pattern with the paint can wood gas stove, the flames goes out very quickly thus requires feeding the stove with fuel bits in sequence. It is very difficult to restart because it cannot build up enough heat stocks inside the stove body because of limited space and the forced air fan

Joshua B. Guinto, Specialist, Sustainable Village Technologies
Email: jed.building.bridges@gmail.com

blowing in cold air. Furthermore, the ashes come out flying with the air blown thus makes the kitchen very messy.

5.9.7. Insights.

- The use of forced air into the stove may actually cause the loss of too much heat.
- There is no preheating of fuel or primary air thus the flame burns off very quickly.
- The fuel and fire chamber may be enlarged to accommodate more embers and allow the stove to have more heat stock.
- The air fan may be regulated to blow in much less air if necessary.

Note: the mixer, dryer, kiln and the tools are new investments which I have been using for the rest of the stove models made out of clay.

5.10. **The Vertical Feeding Rocket Stove** At this point of my search for more solutions, the internet connection in my house was greatly improved and I was able to surf at the net for more information. I came upon the works of Mr. Rok Oblak, a masters student of arts and design at the Emily Carr University in Canada. He conceived the holey roket stove that was made out of clay and burns very clean with the holey fuel briquettes. Through the same network path, I got connected to the Legacy Foundation who is actively promoting the production of fuel briquettes. Not long after, Mr. Richard Stanley of the foundation gave me two books as gifts after seeing the strong potential of my work in bringing the stoves to a more artistic level.

5.10.1. **Features.** With the foregoing experiments, I decided it is about time to move on to the use of clay instead of metal. Clay is an excellent stove building material and offers a very wide range of possibilities.

The idea is to once again resolve the problems faced with the buko chips stove, that is about

Joshua B. Guinto, Specialist, Sustainable Village Technologies
Email: jed.building.bridges@gmail.com

how to make the fuel slide by gravity to the fire chamber as they burn.

5.10.2. **Results of the Tests.** I was expecting that the fuel bits will turn into ash and give enough space for the incoming fresh fuel to fall into the path of the burn. However, the same pattern emerged. The fuel does not slide by itself and somehow get stuck in the fuel feeder at some point in time. This happens with the wood sticks as well as buko chips. The time that the fuel turns into ash is much longer than expected thus blocks the supposed path of the incoming fresh fuel and makes the fire burns backwards to the fuel chamber. This draws back the flames to the fuel feeder instead of gushing into the fire chamber. Soon enough, the fuel bits are burning prematurely at the fuel feeder until they all go up in smoke.

5.10.3. **Insights.** Self feeding properties of the stoves require two critical elements. First, in order to achieve a more uniform slide of the fuel, the properties, the shapes and the size of the fuel will have to be uniform as well. It can be in the form of pellets or shells. This however would require additional energy in breaking, chipping and pelletizing the fuel or perhaps paper balls (the Lee Hite video).Uniformly sized fuel will fall to the fire chamber in controlled and regular speed. Second, the fuel chamber will need to have a smoother surface to allow a smoother slide of the chamber. This may be a stainless metal sheet or a ceramic tile pasted on the walls of the fuel chamber. Finally reducing the tilt of the fuel feeder from 90 degrees to 45 degrees might help.

5.11. **The 45 degrees Self Feeding Terra Cotta Stove.**

This model is in response to the problem found with the vertical feeder model. It cuts the 90 degrees into two thus I expected a more effective draft.

5.11.1. Features

- The fuel feeder was in a 45 degree tilt.
- The stove body was 7.5 centimeters thick. The idea was to create a stove strong enough to hold heavier loads.

Joshua B. Guinto, Specialist, Sustainable Village Technologies
Email: jed.building.bridges@gmail.com

5.11.2. Results of the tests

- The fuel burns very strong. Heat is well contained with the thick insulating clay body.

- The stove body, being very thick was not cooked very well. The fire in the kiln was only able to penetrate 4 centimeters of the stove body, thus the stove was not durable at all.
- Fire would gush back out of the fuel chamber. There is not enough draft to pull in the incoming air in the 45 degree tilt. Also because the pot rest was also not high enough to allow the exit of the flames and the entry of fresh air.
- The fuel did not slide into the fire chamber as expected, particularly the tougher kinds of wood sticks. Generally, the fuel still needed a little pushing and poking.

5.11.3. Insights.

- The height of the pot rest should be increased.
- The height of the fire chamber should be increased.
- The stove body should not be more than 4 centimeters thick.
- Bricks may be used instead for this kind of assembly.
- Still, another option would be not to fire the clay. After forming, let the clay dry very well use the stove immediately after.
- The self feeding mechanism may not be feasible with the fuel that stays intact with the ember e.g. the charred wood stick stays with the wood thus; the wood does not slide into the fire chamber. An

Joshua B. Guinto, Specialist, Sustainable Village Technologies
Email: jed.building.bridges@gmail.com

option would be to cut the wood sticks into shorter bits and install a stainless metal sheet to improve the slide.

6.13.1. **Mr . Booh Holey Roket Stove.** The strength of the stove lies in four operating mechanisms. First, the clay sawdust mix greatly improves the insulating property of the stove. After firing, the saw dust inside the mixture is burned thus creating a void space that delays the heat transfer. Second, the long fuel shelf focuses the reflected heat from the fire chamber thus pre heating the incoming air and the fuel. Third, the tall fire chamber creates a strong draft effect thus pulls in fresh air without the need for external energy. Fourth, primary air is pulled in at the fuel shelf while secondary air is pulled in by the fire chamber. The combination of these provides the right amount of fuel to air ratio thus creating a clean burn of both the fuel and pyrolized gases.

6.13.1.1. **Results of Tests.** The stove provided a strong and clean burn, much stronger and cleaner with the fuel briquettes. It is with my skills in clay works and firing that I had to improve so I may produce better stoves.

6.13.1.2. **Insights.** The different thickness of the walls because of the artworks may cause the stove to

Joshua B. Guinto, Specialist, Sustainable Village Technologies
Email: jed.building.bridges@gmail.com

eventually crack. The uneven expansion of the stove body because of the uneven thickness from the artwork will cause the bond of the clay to weaken. This concern I will have to anticipate. My engagement with the use of clay boosted my work to a much higher and intense level. Clay is abundant in many parts of the province and is very accessible and cheap compared to metal. It does not rust, has a very high insulating property and can be manufactured at the village level with a very low capital input.

6.13.2. **Single Barrel Holey Roket Stove.** This model is the raw version of Mr. Booh. I can produce three times more of this raw stove without the artworks and without the anxiety that the walls will break because of the uneven thickness.

6.13.2.1. **Results of Tests.** The stove burned just as well compared to the Mr. Booh Roket Stove. I even think that it will be more durable because of the regular thickness of its wall. I went further to light the fire from the top in the same manner as the Top Lit Updraft Stove of Mr. Anderson and it burns very clean and strong. On the average, I would only consume four (4) pieces of wood sticks for every cooking session compared to seven pieces in an open three stove. Their limitation however is the accumulation of the ash while cooking and more so with the use of the holey briquettes. Because of the small fire box, the accumulated ash would block the air passage after two loads of cooking. One remedy is to fix a hole at the side of the burner. But still this hole requires scraping the ash sideways which is not very ergonomical.

I also tested raw and unfired clay stoves. And it worked just as well. However, the stove is not very durable and breaks very easily with frequent movement.

Joshua B. Guinto, Specialist, Sustainable Village Technologies
Email: jed.building.bridges@gmail.com

6.13.3. **Insights.** The single barrel stove presents a very cheap solution to poor families in the difficult areas. It can be built with a low level of fabrication skills and it can be fired with almost any kind of agricultural wastes. It burns very efficient and clean.

6.13.4. Firing the stove after plastering and drying is an extra challenge. Building a kiln requires extra skills, resources and human power. But the results of my initial tests on unfired stoves already presents an option to the families to make their stoves and use it immediately after drying. This conclusion is further reinforced by the tutorial for unfired clay stoves http://www.rechoroket.com/Build%20a%20Stove.html

The big limitation however for this technique is that the stove is susceptible to melting if continuously soaked in water and will remain very brittle.

6.13.5. **Double Barrel Holey Roket Stove.** The intention of this design is to resolve the problem of the ash blocking the air passage in the single barrel stoves. With the second smaller barrel beneath the fuel feeder, the ashes can

Joshua B. Guinto, Specialist, Sustainable Village Technologies
Email: jed.building.bridges@gmail.com

be conveniently scraped off. Without my intention, another solution presents itself. The second barrel served as an additional air port. It provides extra pre heated air thus making the burn even stronger with white hot flames.

- **Insights.** This discovery presents an opportunity to respond to the unchartered demand of restaurants and *carenderias* and street food vendors. They require a stronger stove that can receive bigger loads of larger pots and pans. This opportunity would also cut down the demand for wood charcoal thus would reduce the incidence of deforestation. In this respect, I intend to use the fired clay stove as a liner to make a thicker unfired clay wall. This will greatly reduce the cost of fabrication compared to the institutional model made of metal.

Joshua B. Guinto, Specialist, Sustainable Village Technologies
Email: jed.building.bridges@gmail.com

Joshua B. Guinto, Specialist, Sustainable Village Technologies
Email: jed.building.bridges@gmail.com

6.13.6. **Holey Roket Barbeque Grill.** This prototype is a response to the big demand for wood charcoal by the street food vendors selling barbeque. It is a two in one stove that can grill and cook at the same time. This model can grill barbeque with the use of agricultural waste as well as the holey briquettes thus eliminate the need for wood charcoal.

Joshua B. Guinto, Specialist, Sustainable Village Technologies
Email: jed.building.bridges@gmail.com


FIREFLY
MODEL/FEL 503

6.13.6.1. **Results of Tests.** The first cooking session last 1 October 2011 indicates a very strong heat at the metal plate for the barbeque while cooking rice at the same time. The metal plate turns red hot while the rice is boiling. I extended the test further by pulling out the metal plate, thus allowing a frying pan to fit it. This enabled me to fry fish at the pan while the rice is simmering at the cooking port.

This stove grill can be fed with wood sticks as well holey briquettes. It features the double barrel design and can cook two meals at a time.

Joshua B. Guinto, Specialist, Sustainable Village Technologies
Email: jed.building.bridges@gmail.com

Grilling may be done by simply attaching the metal plate. The hot plate radiates off heat to the barbeque thus making a very clean barbeque. If detached, the stove may receive two pots at the same time. This stove grill instantly gained popularity during initial demonstration among women who needs a two burner stove from a single firebox.

Joshua B. Guinto, Specialist, Sustainable Village Technologies
Email: jed.building.bridges@gmail.com

6.13.6.2. **Insights.** The model offers a cheap solution for street food vendors. There are challenges that remain though :

- The stove is very heavy with a weight of about ten (10) kilograms.
- It is vulnerable to vandals and thieves if left on the side streets.
- It would require a table on wheels to enable the sellers to move it safely into their house after the cooking session.

6.13.7. **The Holey Briquettes.** The design was conceived by a network of stovers and was further developed by the Legacy Foundation http://www.legacyfound.org/ The briquette with the hole presents a well balanced mix of fuel and air thus provides a very powerful and clean flame.

6.13.7.1. **Results of Tests.** As anticipated, the briquettes fired very strong and clean with a blue to yellow flames. At first, I used the least amount of paper in a mix to sawdust to a ratio of 8 to 1. I also tested mixtures of grasses with saw dust and paper. However, such mixture turns to ash quickly. After several more recipes, I concluded that the mixture of equal parts of sawdust and paper is best. The briquettes are very tough and would not break during handling and would also fire very strong. I would spend ten briquettes per session for cooking rice, a viand and hot water.

In terms of business, this mixture is also profitable. It responds to the challenge of producing a much powerful briquette with the same amount of labor. With further tests, I concluded that a profitable price, with a daily production rate of 300 briquettes per worker, would be Php 0.85 with a production cost of Php 0.60 per briquette. This is already cheaper than the wood charcoal. A family spends and average of Php 30 per day while they would spend Php 28.50 per day for the briquette.

6.13.7.2. **Insights.** The Legacy Foundation already has an extensive work on the briquette production in Africa and South America. Their technology allows people to make their own recipes. Each situation presents a wide set of choices of materials to be used as fuel. There are seed shells, rice husks, plant fibers, grasses, wood chips and even over ripe fruits that will serve as binders. As of this writing, I am about to give a training to a village of Bogna where pili nuts is abundant. Pili is a native tree of the Philippines and gives a nut believed to be tastier than almonds. It has a

Joshua B. Guinto, Specialist, Sustainable Village Technologies
Email: jed.building.bridges@gmail.com

very tough shell which burns very strong. During the training, we will discover the best mix of 20 % of the pili shells to paper to make strong briquettes.

6.13.8. **The Micro Compound Lever Press.** It was designed by the Engineers without Borders and presented by Mr. Lee Hite in the video. The press is the compacted version of the bigger press. The handle was cut into two without reducing the pressing power of as much as 200 psi. I was very happy to be able to make my own press by following the manual Mr. Hite presented.

6.13.8.1. **Results of Tests.** The press is very easy to use that even children in the neighborhood would play with it and make their own briquettes. We can make

Joshua B. Guinto, Specialist, Sustainable Village Technologies
Email: jed.building.bridges@gmail.com

300 briquettes in a day with two boys working. The briquettes that I produced are well compacted and tight. After drying, the paper – sawdust briquette weighs an average of seventy one (71) grams. One cooking session would require an average of ten (10) of these briquettes for cooking half kilograms of rice, one viand and hot water. If sold at a price of Php 0.85 each briquette, one family would spend Php 25.50 daily. With wood charcoal, they would spend an equivalent of Php 30 to Php 45 daily thus a savings of Php 5 to Php 15 daily or

Php 150 to Php 450 per month.

6.13.8.2. **Insights.** This opens a new enterprise to the villages that I serve. A carpenter in the village may focus on the fabrication of the press while others may focus on the production of the stoves and others on the production of the fuel. A production line may also be organized beginning with collection of materials from schools, offices, shops, farms, gardens to organizing the production center somewhere in a village. It also opens up a possibility of a system of exchange, that is, the briquette serving as the currency for every material collected. Finally the briquette itself maybe sold on a regular basis to patrons of the holey roket stove. With a production cost of Php 0.60 and a

Joshua B. Guinto, Specialist, Sustainable Village Technologies
Email: jed.building.bridges@gmail.com

selling price of Php 0.85 per briquette, they will have a net profit of Php 0.25 or 41.2. %.

6.13.9. The Rocket Stove Kiln April 2011 Model. I learned about the design from the you tube :
http://www.youtube.com/watch?v=zPDa7GSbB88&feature=related

It is a very simple and raw design of a huge brick cylinder with the fire coming from below. The stoves are set in through the open top including the fuel. The kiln that I built receives five stoves, four at the base and two more piled on top of them.




16.14.1. Results of the Tests. The stoves were fired well but not deep enough. The inner layers of the stove walls were not well fired and I got some stoves that would melt in the rain. It is partly because the stove walls are very thick. It is

Joshua B. Guinto, Specialist, Sustainable Village Technologies
Email: jed.building.bridges@gmail.com

also because the kiln is not big enough to receive enough fuel and create enough heat. Loading is also very difficult. Lifting the heavy stoves from the ground and setting them from the top leads to some stoves parts breaking as early as they are being set.

Because of the size and the demand for more heat, I had to build a bigger kiln. It had to be one that can be loaded from the side and one that has more power.

6.13.10. **The Rocket Stove Kiln September 2011 Model.** The design came from the work of Mr. Jon Anderson https://picasaweb.google.com/Jonnygms/RocketOven#slideshow/5598633235210438450.

It was a pizza oven with a rocket stove at the base of the table. The beauty of this design is that it consumes much less fuel and will allow continuous cooking because the fuel feeder is outside and below the oven.

I fully believed in the design because of several reasons :

First, I believe in the rocket stove principles whereby there is a good mix of pre heated air and fuel and the tall chimney that pulls in preheated primary air. What comes out of the burner is already a powerful flame in blue and yellow.

Second, each stove will have to have an equal exposure to the incoming fire because of its thickness and shapes. The dome shape allows each clay stove be set on the sides of the circle while the fire will come at the center.

Third, it has a much simple construction than the anagama models by being able to fix the chimney at the top of the oven chamber. With the anagama, the stoves will be set some at the front and some at the back. The linear position of the stoves along the path of the fire results to poor cooking in many portions of the stoves.

And for these reasons that I built my new kiln by expanding the pizza oven. It took me the whole month of September to build with the bricks that I made

Joshua B. Guinto, Specialist, Sustainable Village Technologies
Email: jed.building.bridges@gmail.com

earlier. Then there is a whole lot of clay, cow manure, wood ash and molasses plus some bamboo, metal screen and iron bars as frames. I had to build first the fire box and the platform. After two weeks, I began plastering and forming the oven.

At this point, I had to make a crucial decision whether to use bricks for the oven walls or should I plaster it with fresh clay. After much contemplation, I

Joshua B. Guinto, Specialist, Sustainable Village Technologies
Email: jed.building.bridges@gmail.com

decided to plaster fresh clay. I though then that it is easier to set and will also provide a new experience into my knowledge pool.

After two weeks of plastering, I slowly set fire into it everyday and building the heat after a week of slow firing while the outer walls are dried in the sun. Soon, I built a roof over it made of wood, bamboo and metal sheets.

Joshua B. Guinto, Specialist, Sustainable Village Technologies
Email: jed.building.bridges@gmail.com

6.13.10.1. **Results of Tests.** Beginning the last week of September, I began to carefully heat up the oven. The oven fired very strong. It took about fifteen minutes to get the oven hot to bake bread. (I could not tell the exact temperature because I could not find the appropriate thermometer for the test from the local shops). On the evening of 29th September 2011, I decided to bake a whole chicken into it as a prelude to the full firing with the clay stoves. And so we after an hour and a half, we were already dining with a whole grilled chicken as a well deserved prize for a whole month of hard work.

The following day, I fired it further to bake the clay stoves. This time with much stronger flames enough to make the clay stove glow red. I carefully filled the oven chamber with eight clay stoves and in between them are thick chunks of bamboo poles that I collected earlier from the furniture shops.

For twelve hours, we were feeding the fuel chamber with fuel beginning with dried buko shells and picking up the phase with bamboo poles and ended with bigger chunks of wood. On the third hour, the clay stoves are already glowing red. We can see them from the spy holes that we fixed on four sides of the dome. The spy holes also served as stoking holes on which we can either feed more fuel or manipulate the path of the flames to reach the slower portion of the dome.

I fired a total of twenty four stoves in three batches. And they are much stronger with a much deeper red color plus a tinging sound indicating strong bond. I would conclude that the quality of my work improved from a rate of 75 % to 90 % based on the reduction of breakage, strength of the bond, fuel consumed and man hours spent.

Joshua B. Guinto, Specialist, Sustainable Village Technologies
Email: jed.building.bridges@gmail.com

However, after the third firing, the oven showed the burden of very intense firing. The metal screens began peeling off and soon after, to my dismay, the metal bar that I fixed as a ring to hold the bamboo arc together also fell of and bringing down a whole lot of pack of clay. The oven wall have crumbled too soon and is no longer usable.

6.13.10.2. **Insights.** I was very successful in making an oven for bread, pizza and whole chicken. However, by firing it for clay stoves, the design was abused. For the coming month, I will again have to rebuild the oven, this time with bricks and with a strong mortar of white clay, ball clay with a temper of finely ground burned clay. I will also have to carefully set the dome with better instruments.

6. **Field Tests and Client's Response**

6.1. **At my own home,** I decided to stop using the gas. Gas costs Php 780 pesos monthly and with the holey roket stove, I can simply get a good stock of fuel wood from my farm every weekend. In the morning, when everyone is busy, I use holey briquettes instead but would use wood sticks at lunch and dinner time. However, the intermittent sooth from the wood sticks however have already caused the walls of the kitchen to darken and the cooking pots now really black. But we do not mind because the food tasted much better than those cooked with gas.

6.2. **Edwin Millamina** works at the Social Security System as a security guard. He is a father of six and his wife is unemployed and they live in a slum area in the town of Daet. He received a paint can rocket stove. Here are among his remarks in a short interview on 21 October 2011:

Joshua B. Guinto, Specialist, Sustainable Village Technologies
Email: jed.building.bridges@gmail.com

I still use the stove (after six months) with no problem. I feed it with wood sticks that I pick up from the neighborhood. Before this stove, I spend as much as Php 45 daily to buy wood charcoal. Now I would only spend not more than PHp 10 daily, that is for wood charcoal if there is not enough wood sticks that I gathered. The smoke is not a problem because the stove has low emissions. The stove body has not rusted enough; I think it is because I am using it everyday and so the rust could not catch up.

6.3. **Flora Pancho** is a mother of seven. Her husband is a part time security officer of the village and is most of the time underemployed. She received a single barrel holey rocket stove. SheThe following are her remarks:

I am very much satisfied with the performance of the stove. The stove gives strong fire and uses very little fuel that is from six pieces of wood sticks to only three. I can simply pick up some wood sticks that I may find along the way while coming from my work.

I organized a kitchen outside of her small house beneath the eaves of the roof that even neighbors would sometimes come by to cook rice in this stove.

6.4. **Sally Encinas** works as a tailor of school uniform. She lives in the Gawad Kalinga Housing Project. She bought a single barrel stove for Php 300. The following are among her remarks:

Before the stove, i buy wood charcoal at PHp 75 pesos per week. There are times when i would also buy gas whenever all my children are at my house for a visit.

With this stove, i would instead buy coco shells at a cost of PHp 10 that is consumable in three days. Then i chanced upon a load of coconut husks in the garbage truck. I asked for it and now using it along with the coco charcoal. I chopped the coco husks small and then set it alternately in a tow with the shells This discovery allows me to cook with a steady fire. The coco

Joshua B. Guinto, Specialist, Sustainable Village Technologies
Email: jed.building.bridges@gmail.com

shells burns very strong but abruptly. The husks on the other hand burn in steady smoldering ember. Thus the combination of the two in a tow is excellent.

Whenever i can pick some twigs, i do not have to buy any fuel at all. So my savings from the fuel i already use for the school expenses of my children.

The kettles get heavy black sooth through long use but i don't mind.

6.5. **Isabelita Dando of** Brgy Alawihao bought the stove for Php 370 through Sally Encinas. She is an active member of the Kapitbahayan of the Gawad Kalinga Project of Brgy Alawihao along with Sally Encinas. Her husband is a tricycle driver. The following are her accounts.

Before, we use to buy one bag of wood charcoal at Php 180 per week. With this stove, we do not have to buy any fuel at all. My husband is now happy to pick tree trimmings in the neighborhood and dry them. My children are very happy with the flames of the stove. But they oftentimes over do it. They plug in too much fuel and gaze on the red flames engulfing the entire pot up to its cover. (At this point, i have to reiterate that the power comes in the right combination of fuel and air and the more powerful flames are the bluish yellow.) Another good thing is that we can use anything that burns in the stove - like coco shells, paper that we twist really tight, and twigs.

I forbid my children to use the briquettes. Although i am fully convinced that it if very clean and powerful, I want to save it as a souvenir item which I can show to my guests. I kept the briquettes tucked in my kitchen ceiling as souvenir and to explain them the merits of the stove.

Sally and Belinda are very eager to promote the stove to their neighbors. There are now a good number of potential clients but do not have the money to buy them yet.

6.6. **Dra. Tejada** is a practicing government physician. She bought a single barrel sculpted model at Php 670. However, her house helpers do not want to use the stove and instead kept on using the LPG for reasons of convenience, to the owner's big disappointment.

Joshua B. Guinto, Specialist, Sustainable Village Technologies
Email: jed.building.bridges@gmail.com

6.7. **Lilibeth Ravida** of Vinzons is a mother of five and works fulltime to care for her four children. Her husband is a farmer and a skilled construction worker. She received a single barrel stove. The following are her remarks:

I am very satisfied with the stove. It consumes only a third of the wood sticks otherwise burned with the three stone stove. Even mildly damp sticks would burn well in a hot stove. It has very minimal smoke that is very briefly every time the fuel sticks are pushed into the fire. Before this, I would suffer from heavy smoke that I smell heavily at the end of the day. The newly painted house also turned darker because of the sooth. We consume too much wood for fuel. With this new stove, a consumption of wood for a day would last for more than three days. The only complaint remaining from my housemates is the need for the fuel wood to be chopped small.

6.8. **Bert Ella** is a businessman. He bought a sculpted model of the single barrel stove for Php 670.

This clay stove fires very amazing. I am now using wood sticks that I pick up from my yard. Also I decided to shelf off my other wood charcoal stove. Now that there is such as stove for wood sticks, I think all that a family would need for a sustainable source of wood fuel is a huge acacia tree which they can trim the branches whenever they need fuel. (Acacia is a nitrogen fixing tree species and it produces a lot of branches and foliage. The leaves are excellent mulch for the soil as a source of nitrogen).

6.9. **Nelson Mabesa** is a farmer and the president of the homeowners association of the Gawad Kalinga Housing Project at the village of Bibirao. He received a single barrel holey roket stove. He is the President of the Gawad Kalinga Housing Project at the village of Bibirao, Daet Camarines norte. They use wood charcoal for fuel and spends as much as Php 30 daily to buy the wood charcoal. The following are the excerpts from the interview :

I have promoted the stove in a meeting of the neighbors. I cooked a big pot on it with five kilograms of porridge and my neighbors are very impressed.

Nelson is very pleased to have the stove. Notice the wood charcoal stove beside the roket stove and his collection of wood sticks.

The stove burns very strong. I can even use wood sticks with it. As soon as there is enough embers and the stove is hot enough, I can even feed it with damp sticks.

There is much less smoke and I think we can use it inside the house whenever there is a typhoon.

There are very much eager takers of the stove. However, with the price of Php 370, there are only six of my neighbors who are willing to file their purchase order. But still, none among them have the money to buy the stove.

Joshua B. Guinto, Specialist, Sustainable Village Technologies
Email: jed.building.bridges@gmail.com

6.10. **Gina Reyes is a fulltime homemaker.** Her husband is an employee at the local electric cooperative. She bought one single burner holey rocket stove for Php 370.

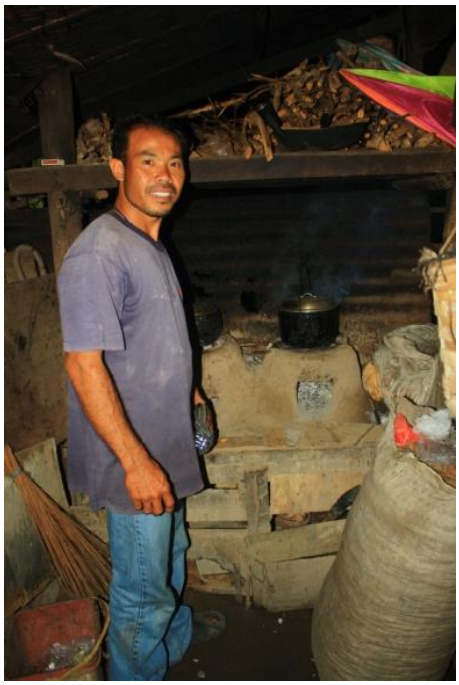
I am very much impressed by the stove. The stove body does not get very hot compared to the conventional wood charcoal stove. This one that I have now I will use to cook boiled peanuts and rice cakes.

However, what I really wanted is a bread oven. This is my long time dream that is to have a small bakery in this neighborhood. I want to bake bread and cakes. I am already planning to buy a gas oven out of desperation but now that Mr. Guinto told me about his experiment with the clay oven, then I would like to have one myself.

Gina's daughter happily with her mom's new stove. (Gina does not want to be in the photo.).

7.1.3 The Family of Efren Abasula, 18 October 2011. I have become very fond of this family and every visit is always a warm welcome. I first met them at the evacuation center at the town plaza in 2007. They were among the hundreds of families that evacuated during the flooding in their village.

Joshua B. Guinto, Specialist, Sustainable Village Technologies
Email: jed.building.bridges@gmail.com



During the previous episode of this project, I brought them a rice hull stove made of metal. It burns very strong and is lightweight. I went further in trying to organize the three families in the neighborhood to come together to a common kitchen. The attempt however was not successful because after several months of heavy use, the stove eventually succumbed to rust. The neighbors could not also come into a comfortable arrangement about the cooking schedule and the regular procurement of the fuel as a common task.

On this visit of October 18 2011, I found them using another stove that Efren (the father built) out of ash. He fashioned the stove to receive two cooking ports. They use wood sticks that they gather from the neighborhood and just very recently, they were able to gather big bags of pili shells from his brother from another village.

Joshua B. Guinto, Specialist, Sustainable Village Technologies
Email: jed.building.bridges@gmail.com

They are lamenting about every flooding in their village and about how miserable their situation is at the evacuation center. They would still have to buy another wood charcoal stove and charcoal for their cooking at the evacuation center. With this stove, they feel that they will be able to manage better. It is light weight and would require a simple stable platform and then they can already cook in an instant. They could even bring along their fuel of wood sticks and pili shells. Pili shells are

very powerful kind of fuel. They burn very furious but would require enough preheating before they would burst into flames.

During my interview with their daughter Weslin, she complained about the heavy smoke coming from his father's stove. The manner of firing was first to set the pili shells over the iron grills and then light a small fire down below with wood sticks. This combination produces a very thick smoke towards the house and on the metal pots. Photo shows Efren actually scraping off the tar on the sides of the pot. He would drop the tar into fire and would be amazed how it bursts into flame.

Without criticizing his work on the stove ash, I explained to him the mechanisms of the holey roket stove.

Joshua B. Guinto, Specialist, Sustainable Village Technologies
Email: jed.building.bridges@gmail.com

And so we set the stove for cooking by first igniting a few pieces of wood sticks at the burning chamber. We then set the burning wood sticks at the fuel shelf. As soon as there is already enough fire going, we dropped some pieces of the shells into the fire chamber through the gap between the stove and the base of the pot. The pili shells would smoke briefly but in less than a minute, they would burst into very strong yellow flame. Sensing that the stove is already hot enough, we put some shells into the metal fuel grate that we cut from milk cans. Soon enough, the flames would crawl to the shells without producing heavy smoke but cleaner yellow flames.

I left off with this experience to the family and with the hope that the lessons for the evening would sink into them especially the father so he would eventually make some improvements into his own creation. The wife also agreed to be present at my demonstration on the coming Sunday. She is very eager to see how the clay stove grill would work because she would really want to open up a little business of selling barbeques on the side streets.

Joshua B. Guinto, Specialist, Sustainable Village Technologies
Email: jed.building.bridges@gmail.com

Joshua B. Guinto, Specialist, Sustainable Village Technologies
Email: jed.building.bridges@gmail.com

Princess, one of the daughters enjoys dropping pili shells into the fire and watches them burst into strong clean flame (left). Efren made his own discovery by scraping off the heavy tar in his pot from too much smoke of his other stove. He discovered that the tar burns very strong and learned how much fuel is being wasted with stoves that give off too much smoke.

Joshua B. Guinto, Specialist, Sustainable Village Technologies
Email: jed.building.bridges@gmail.com

7. **Winifreda Tolin** of Brgy, Kanapawan

Kanapawan is a village in the forested part of the town of Labo. Ate Winnie, as I fondly call her is an active member of the Kapisanan ng Maliliit na Magniniyog sa Brgy. Kanapawan (Small Coconut Farmers Cooperative. The Cooperative is an association organized by the Philippine Federation of Environmental Concerns (PFEC) and NGO that has worked in the country for environmental projects. For this village, their major interventions are reforestation, agroforestry and the production of citronella oil.

Ate Winnie received the stove as a token after she lend her house for several months during my stay in the village as a technical consultant to their project on the citronella oil production. She eagerly used it and dared to do experiments with the single barrel stove.

On this visit (22 October 2011), I chanced upon a meeting of the members of the cooperative. She gladly told her story to the members.

> *The stove is very helpful in reducing my stress in gathering fuel. I can use even small wood sticks which I gather from my houseyard. I do not even have to go too far or spend too much time gathering fuel wood. More so I no longer have to buy wood charcoal from the merchants.*
>
> *I went further to test it to cook six kilograms of rice (All the while I was testing it with half a kilogram of rice only). With six kilograms of rice, the big pot rest on the stove. While simmering, I decided to put a damp cloth on top of the metal pot. (this I presume is to deflect the heat back to the rice instead of it escaping).And so the experiment was successful with six kilograms of rice.*

This testimony boosted the demand for the stove for the rest of the members of the cooperative. The stove grill is also very popular. They were amazed how two pots can fit nicely in a very small clay stove. More of them exclaimed to see the stove truck.

One very important component of this collaboration is that the clay which I now use for the stoves come from this village. I discovered this huge clay deposit when one of my workers at the bamboo house dryer showed me the spot in the village where they found a kind of red clay that sticks heavily to their boots. As of this writing, I hauled off another load of clay in my truck and will soon produce a fresh batch of stoves. It was under an experimental arrangement with the land owner that a load of clay in my truck (that is about three cubic meters) will be exchanged for a clay stove.

I am anticipating (and hoping) that they will soon ask for a skills training so they can make the stoves on their own. Furthermore, they are now into discussions on contract production of the stove for the members of the cooperative.

Joshua B. Guinto, Specialist, Sustainable Village Technologies
Email: jed.building.bridges@gmail.com

8. **Sarah Bernardino** of Barangay Kanapawan is another member of the KMMBK Cooperative. She plants citronella grass and works as among the operators of the distillery plant. She received the stove sometime in February 2011 that is before I was into the clay stoves. She is still using the stove in her kitchen. She is happy that she greatly reduced the consumption of wood charcoal and can even use very few wood sticks. She can even cook on a big pot over it with a single wood sticks about two feet long instead of four in a three stone stove.

I always receive a warm welcome from the children of this neighborhood in the village of Kanapawan. From left to right is Mac Mac, Mj, Sarah with her stove and Onyok.

Joshua B. Guinto, Specialist, Sustainable Village Technologies
Email: jed.building.bridges@gmail.com

9. **Bayani and Lolit** of Sitio Contod, Barangay Guinacutan, Vinzons is a couple living on the edge. Their house is built between the roadside and the ditches of the rice paddies at the outskirts of the town. This part of town is among the lowest and would easily be submerged underwater during every flood. It is where the waters of the swollen rivers and the rainwater from the town meet. Evacuation is already a part of their life routine. And each time they have to move fast to move to a safer ground bringing their essentials including their stove.

The remains of the old rocket stove after two years of full time service.

I met them first during the previous episode of this project. It is when I delivered one day training for this neighborhood on how to make the rocket stove out of old metal roof. The metal roof was cut filled with a combination of soil and rice hull, another metal canister was inserted to the side and in less than two hours, we already have a strong fuel efficient stove fed with wood sticks.

Joshua B. Guinto, Specialist, Sustainable Village Technologies
Email: jed.building.bridges@gmail.com

Bayani and Lolit are very happy to use the holey roket stove, which I gave to them as gift after getting their story.

interview. But things got brighter upon getting a beautiful story about how this stove has been part of their daily living. Bayani told me that they were able to make six more stoves of this kind for other people. The soil-rice hull mix had to be changed at some point. He prepared a mixture of sand, cement and lime and filled the stove body plus a final coating at the wall of the fire chamber with a thick salt solution.

They would bring this stove to the evacuation center and would greatly help them ease the burden of cooking and gathering of firewood. Other families without this stove have to wait for their cue to a wood charcoal stove before they can cook. It has also served the neighborhood. About five families in the neighborhood would cook in this stove one after the other. Its life finally came to an end on the day when they are on another run. The stove was placed on top of the tricycle but because of haste, they neglected to secure it firmly with a rope. And so the stove fell of the cab to the cement ground and

Joshua B. Guinto, Specialist, Sustainable Village Technologies
Email: jed.building.bridges@gmail.com

broke into pieces. Nevertheless, they are thankful for its two years of service and are still saving the remaining metal parts to build a new one.

The coming of the holey rocket stove was met with another wave of enthusiasm in the neighborhood. I was just wondering if I should have left them to build another rocket stove instead. Anyhow, they received the roket stove with excitement and were soon cooking for another week.

During this November 11 interview, they told me about how thankful they are with the new stove. The following are their remarks.

We are amazed that his stove is small but very powerful. We can cook with just two pieces of firewood instead of seven. There is much less smoke even without the metal grate. Five families in this neighborhood share in the same stove. We also receive a lot of inquiries from people passing by who seems to be interested to buy one.

Joshua B. Guinto, Specialist, Sustainable Village Technologies
Email: jed.building.bridges@gmail.com

10. Conclusion

Summary of Prototypes and Immediate Interventions

Model	Operating mechanisms under study	Upsides	Downsides	Problems Identified	Components for Improvement
Rocket Stove from old metal roof	An extended skirt as a protection against strong winds. The use of soil, rice hull and mud as an insulating layer. The durability of the stove against rust and flooding.	It can be built in about one and a half hours using recycled materials.	The stove body succumbs to rust after a few months. The insulating layer disintegrates in time and during flooding. The stove cannot be brought to the evacuation centers during flooding.	The stove is not very durable. The supply of old metal roof may also be limiting.	The use of terra cotta for the stove body to keep intact even when submerged to flood waters. The stove should be lightweight and can be brought to the evacuation centers during emergency situations.
Buko Chips Stove	Vertical Feeder	Can be built in less than two hours with recycled materials	The stove body succumbs to rust in a few months.	The fuels do not fall smoothly into the fire box.	Use terra cotta for the stove body.
			Difficult to control the flame and smoke.		Install a stainless metal sheet in the fuel feeder.
					Provide regularly sized and shaped fuel.
Brick Rocket Stove	45 degree fuel slide Protective metal casing.	Very durable and can last for generations.	Very heavy. Can only receive short sized fuel.	The fuel feeder is very short. The bricks used are very	Install a long fuel feeder made of terra cotta and metal contraptions.

Joshua B. Guinto, Specialist, Sustainable Village Technologies
Email: jed.building.bridges@gmail.com

				compact.	
					Create lightweight bricks with clay and rice husks.
Paint Can Rocket Stove					
TLUD Wood Gas Stove					

11. Windows Unfolding

11.1. Skills Training Programs. On October 27 to 29, 2011, I was the resource person of a skills training on the fabrication of the holey roket stoves and fuel briquettes for the fisher folks of the village of Bogna in the town of Bacon in the province of Sorsogon. It was organized by the Coastal CORE, an NGO serving the poor fisher folks of the province. The three day activity focused on the values of environmental protection, the concepts and principles of stove design. It also featured practical workshops beginning with working with clay, plastering the stoves, making the fuel briquettes out of several recipes and cooking with the stoves. It concluded with a session on how to establish a village stove fuel fabrication workshop as their livelihood enterprise.

With this breakthrough I intend to offer similar service to other parts of the country. There are several inquiries on line which I may respond to in the coming months.

Joshua B. Guinto, Specialist, Sustainable Village Technologies
Email: jed.building.bridges@gmail.com

The participants consist of fifteen (15) fishermen. Their families suffer from the high costs of wood charcoal and loss of livelihood whenever the weather forbids them to catch fish. In this photo, I was demonstrating how to cut a PVC pipe in a 45 degree angle. The photo below shows them holding on to their miniature stove models as part of the exercises.

Joshua B. Guinto, Specialist, Sustainable Village Technologies
Email: jed.building.bridges@gmail.com

Right now, i am financially constrained in many respects and is only subsisting in off and on consultancy projects for my clients in the NGO community. Nevertheless, should enough resources come along; I intend to bring the project further until it gets institutionalized in regular programs of the government, the NGOs and rural organizations.

Plans and Ambitions

Right now, i am financially constrained in many respects and is only subsisting in off and on consultancy projects for my clients in the NGO community. Nevertheless, should enough resources come along; I intend to bring the project further until it gets institutionalized in regular programs of the government, the NGOs and rural organizations.

12.1. **Improving the Fabrication Workshop.** My shop is still in its very raw state. It measures 9 meters by five meters (9m X 5 m) and is made of bamboo and anahaw thatched roof. It is simply a roof above our heads where all the activities happen. However, the roof is only about 65 % complete and I had to wrap parts of the roof with provisional tarpaulin sheets. The sheets are now degraded to intense sun and rains and so it pours inside the shop every time it rains. It also requires a decent and secured tool room, a living quarters for the workers plus water and electrical installations.

12.2. **Creating Second Level Designs and Prototypes.** The lessons that I gathered for this episode will form part of the pool of knowledge and options. I will integrate all the strengths and rectify the weaknesses of each model and then fabricate a fresh generation of stoves. Through this, clients will then come to understand the pitfalls and the mechanisms of the components.

12.3. **Publication of a Catalogue and a Coffee Table Book of the Prototypes and the Stories around About the Project.** This project will work to promote the positive values of the project while providing them options to solve their own stove related problems. Or it can be a serious guide book which can teach people how to build their own stoves.

12.4. **Holding a Technological Exposition and Concert.** It is will be a daring event but will greatly boost the gains of the project. The stove models, be successful or not will be on display with the commentaries next to it. And then as a musician, I can play music of the songs including those I wrote along the theme of development and global cooperation.

12.5. **Organizing and Holding Trainer's Training Sessions.** As of this writing, I am already receiving inquiries to buy the stove units in many parts of the country while others are asking for skills training session. One inquiry is from the town of Bato in the province of Camarines Sur. The town suffers from flooding from heavy rains as well as because of the massive clogging of their lake from water hyacinth. The town mayor is seeking for a solution that would convert the water hyacinth into fuel.

Joshua B. Guinto, Specialist, Sustainable Village Technologies
Email: jed.building.bridges@gmail.com